BASIC ELECTRONICS ENGINEERING

(RBL1B002)

MODULE-1

$$\text{BJT} = Bipoalr\ Junction\ Transistor$$

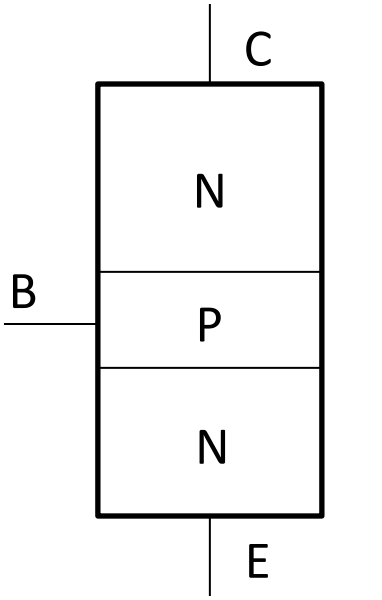
$$Transistor = Transfer + Resistor$$

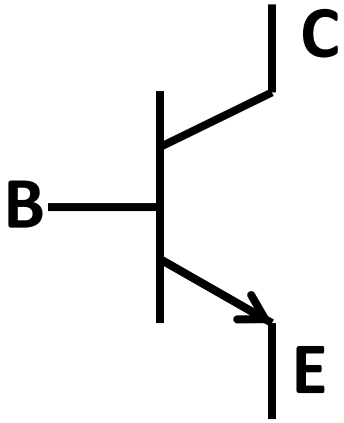
BIPOLAR JUNCTION TRANSISTOR (BJT)

- The transistor is a three layer semiconductor device consisting of either two N-type & one P-type or two P-type & one N-type semiconductor.
- It has three terminals
  - Base (B)
  - Emitter (E)
  - Collector (C)
- In this device both electrons & holes take part in the conduction. Hence it is called as *bipolar.*

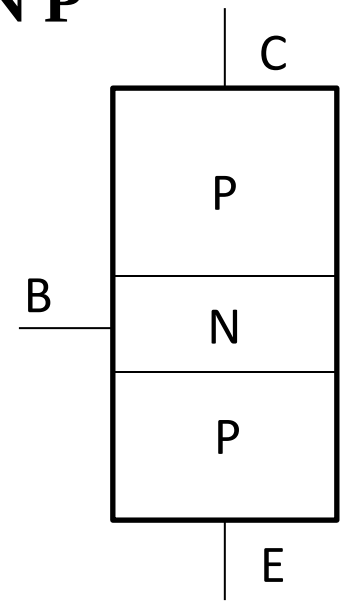
STRUCTURE & SYMBOL OF BJT

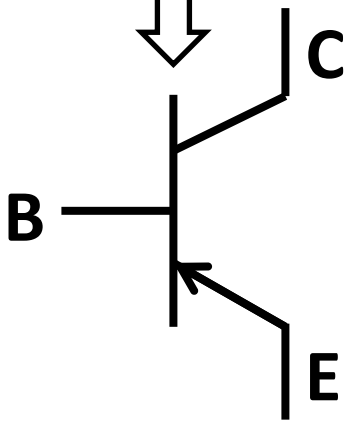
N P N





P N P





TERMINALS

1. EMITTER

- The main function of the emitter terminal is to supply the majority charge carriers to the base.
- For NPN type BJT the majority charge carriers are electrons & for PNP type BJT the majority charge carriers are holes.
- The emitter is always heavily doped.

2. BASE

- The base is a thin layer and it is lightly doped. It’s main function is to pass the majority charge carriers to the collector.

3. COLLECTOR

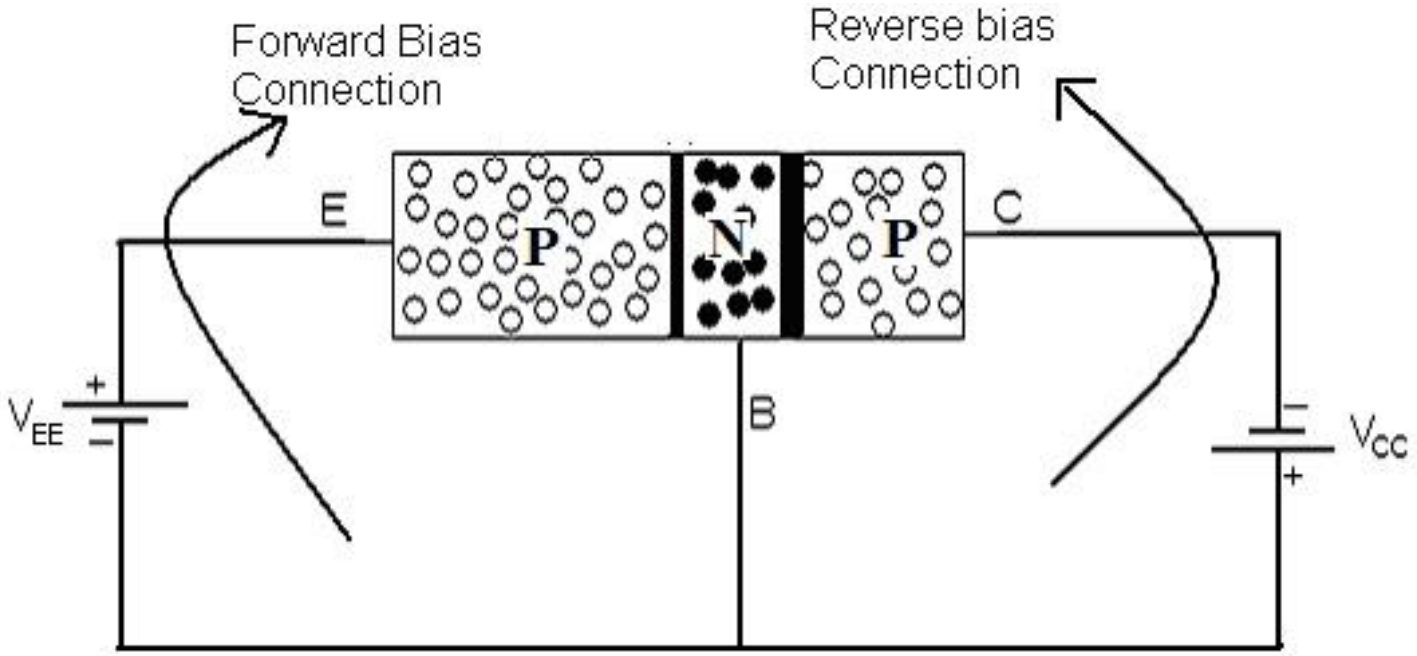
- The main function of the collector is to collect the majority charge carriers coming from the base.
- It is moderately doped.

TRANSISTOR CONFIGURATION

- The BJT can be connected in circuit in 3 different configurations:
  - Common Base (CB)
  - Common Emitter (CE)
  - Common Collector (CC)

Common Base (CB)

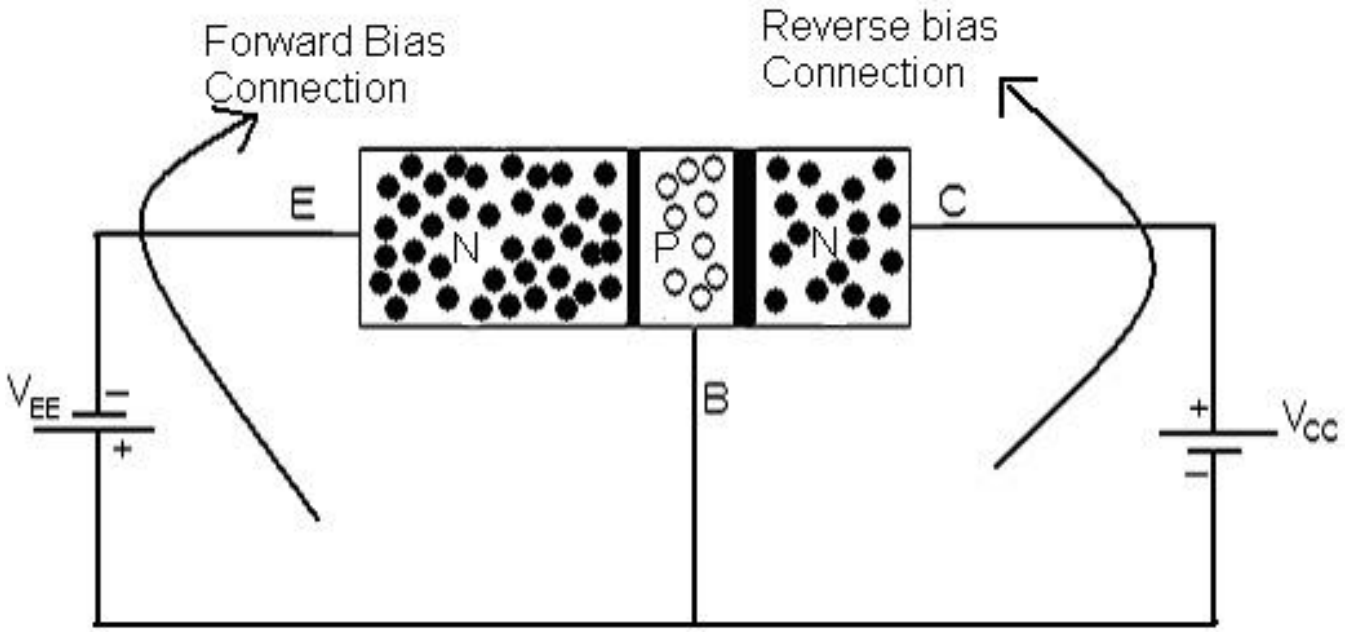
PNP Type



- For the Operation of the transistor, the Emitter – Base junction must be forward bias and Collector – Base junction must be reverse bias.
- The forward bias at the emitter terminal will repel the holes from emitter side towards the base constituting emitter current (I_E).
- As the base is lightly doped, some of the holes will recombine with electron and rest of holes will enter the collector.
- Due to this, a current at the base is observed which is called as base current (I_B).
- The holes entering into the collector will constitute collector current (I_C).
- Hence the majority carriers from emitter travels to the collector through the base.
- Hence, $I_E = I_B + I_C$

Common Base (CB)

NPN Type



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Current Amplification Factor (α)

It is the ratio of collector current to the emitter current at constant collector base voltage.

i.e. $\alpha = \left.\frac{I_C}{I_E}\right|_{V_{CB}=Constant}$

Collector Current (I_C)

The collector current consists of:

1. The part of emitter current which reaches from the emitter and is given by

$$I_C = \alpha \cdot I_E$$

2. The leakage current due to the flow of minority carrier across CB junction and is given by I_{CBO}

Hence the total collector current is given by

$$I_c = \alpha \cdot I_E + I_{CBO}$$

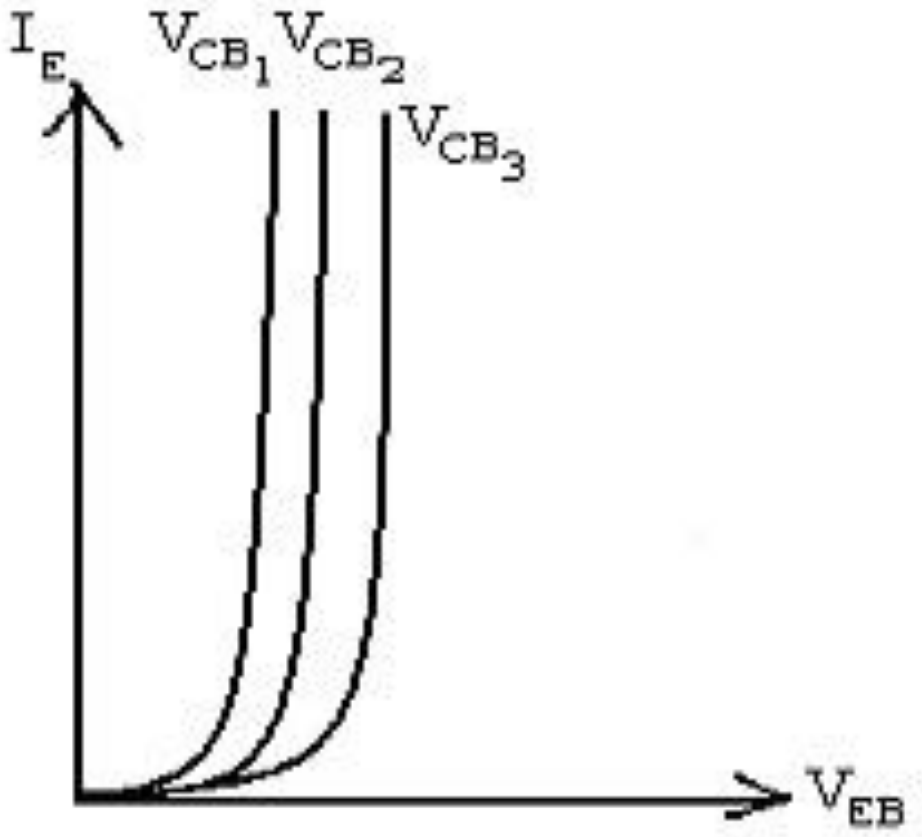
$$\Rightarrow I_C = \alpha(I_B + I_C) + I_{CBO}$$

$$\Rightarrow I_C(1 - \alpha) = \alpha I_B + I_{CBO}$$

$$\Rightarrow I_C = \frac{\alpha}{1-\alpha} I_B + \frac{1}{1-\alpha} I_{CBO}$$

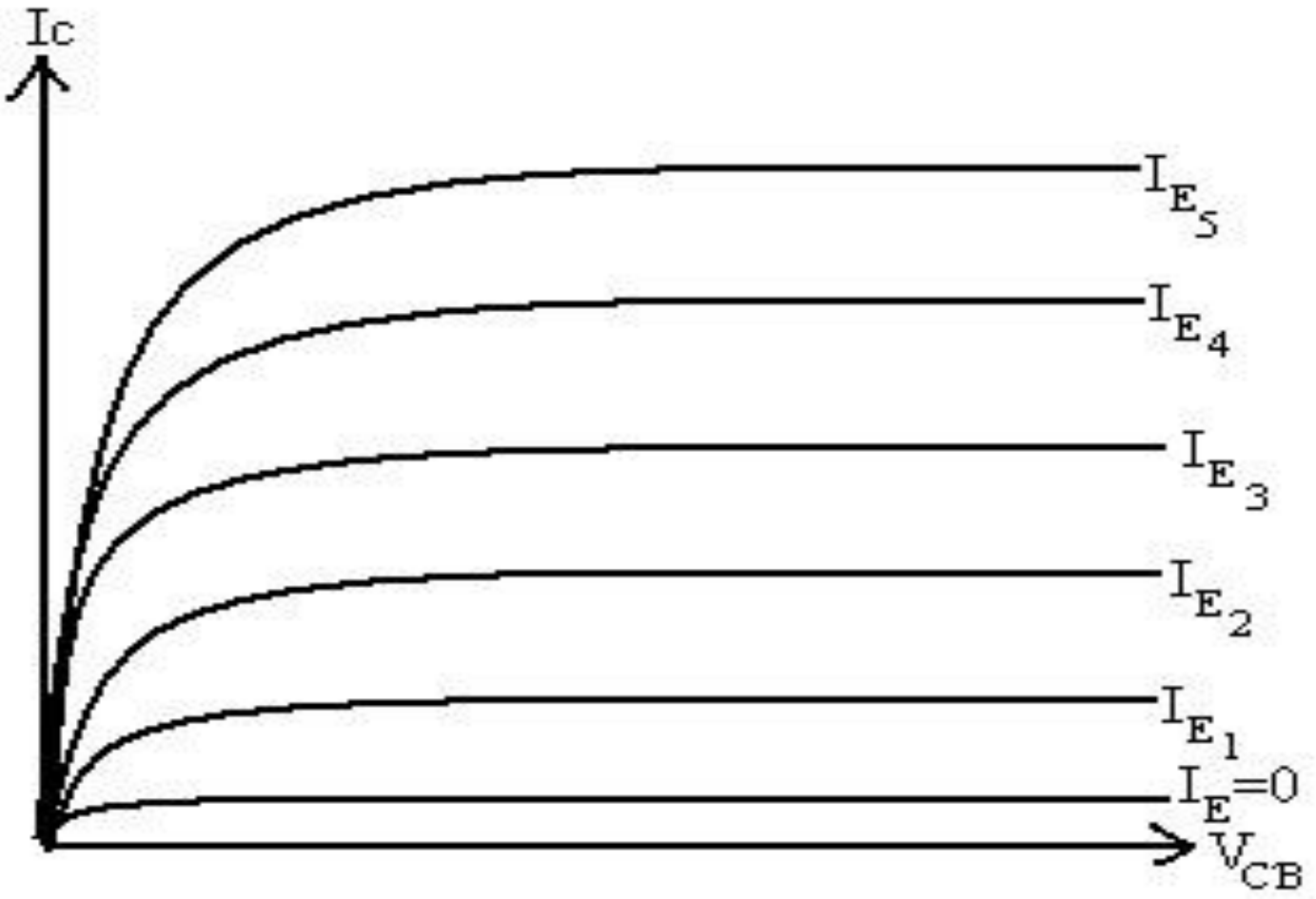
Input VI Characteristics

It is the curve between the current I_E and voltage V_{EB} at constant collector base voltage V_{CB}.



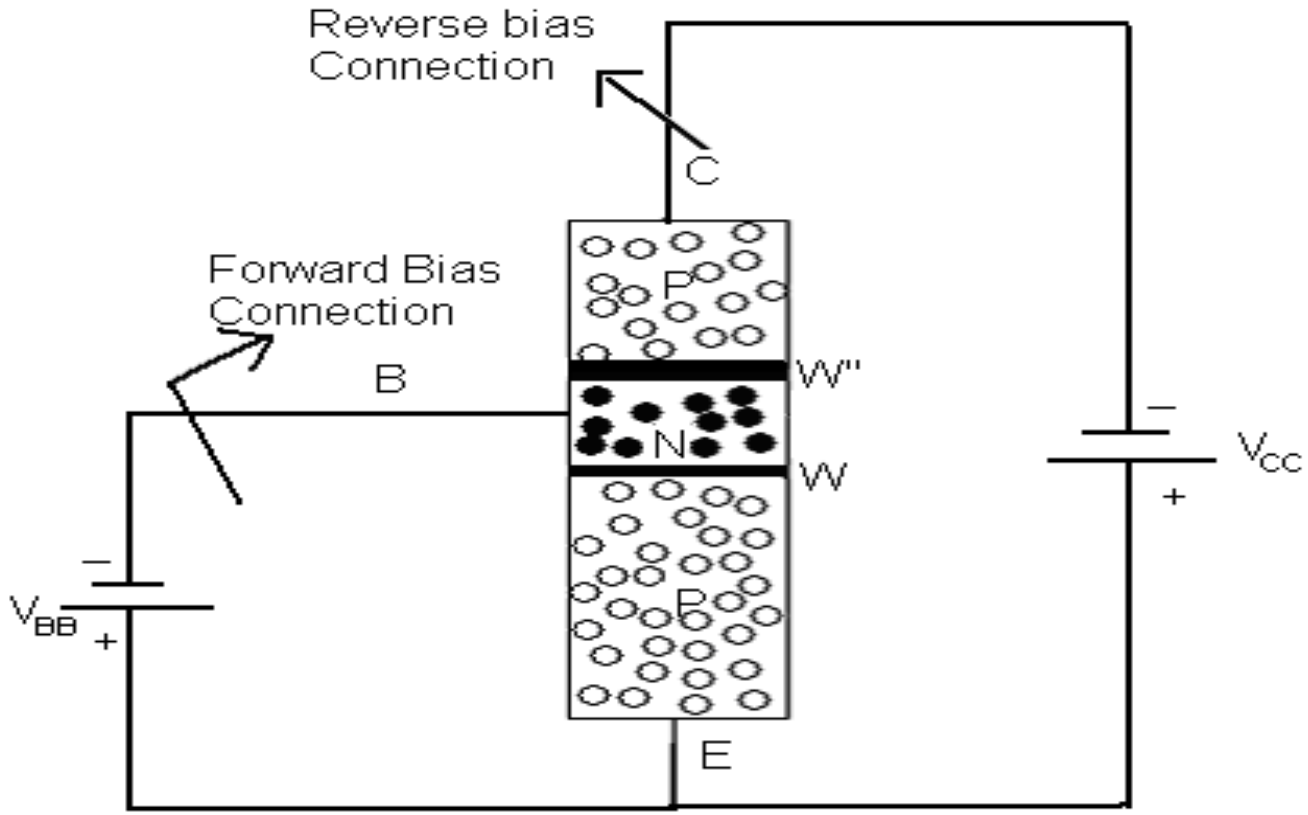
Output VI Characteristics

It is the curve between the current I_C and voltage V_{CB} at constant collector base voltage I_E.



Common Emitter (CE)

PNP Type



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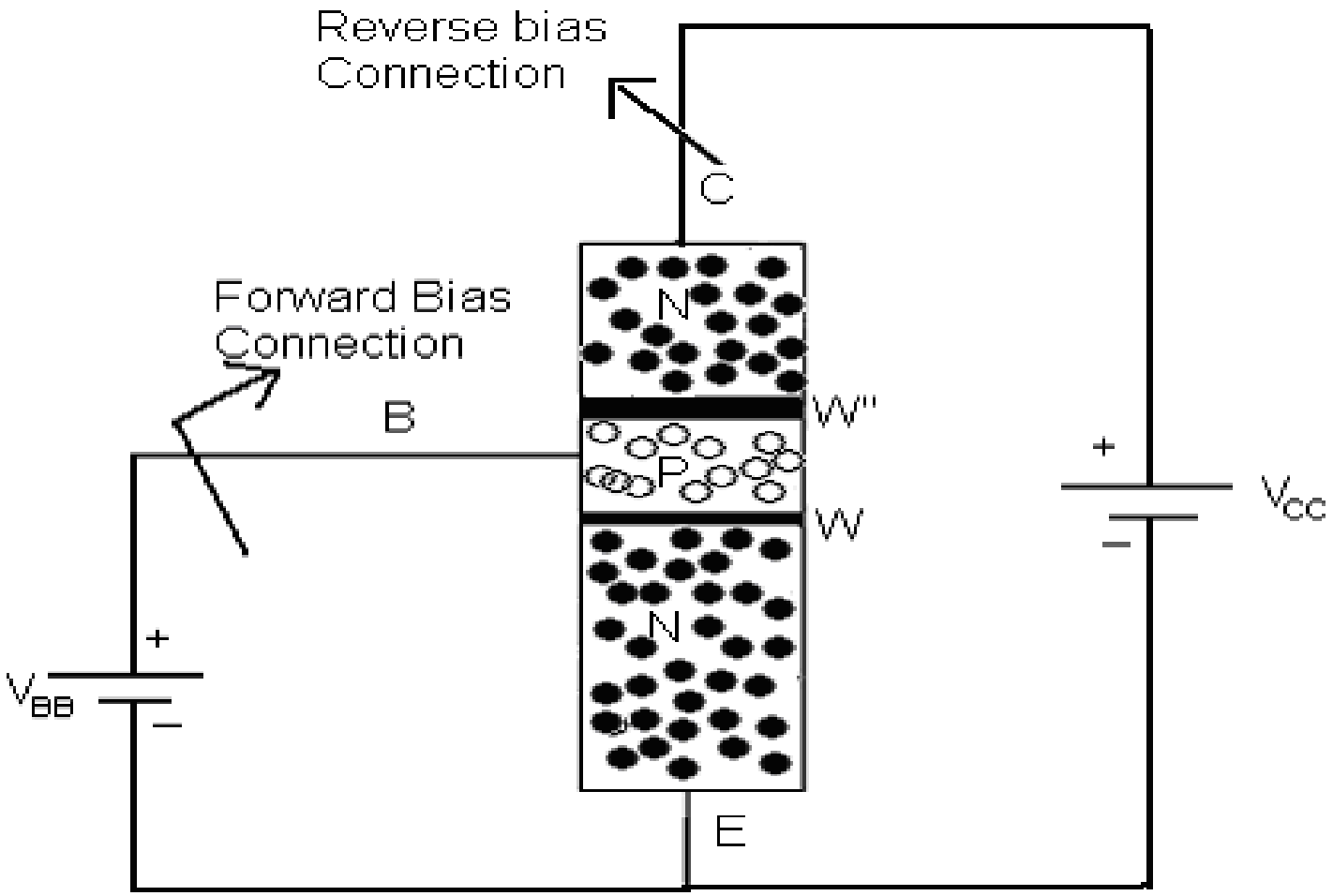
NPN Type



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Current Amplification Factor (β)

It is the ratio of collector current to the base current at constant collector emitter voltage.

i.e. $\beta = \left.\frac{I_C}{I_B}\right|_{V_{CE}=Constant}$

 # The relation between α & β.

$$\beta = \frac{I_C}{I_B} = \frac{I_C}{I_E - I_C} = \frac{I_C/I_E}{I_E/I_E - I_C/I_E} = \frac{\alpha}{1-\alpha}$$

Collector Current (I_C)

We know that,

$$I_C = \frac{\alpha}{1-\alpha} I_B + \frac{1}{1-\alpha} I_{CBO}$$

When $I_B = 0$, i.e. base is open, the collector current will be the current across the emitter & is represented as I_{CEO}.

$$\therefore \; I_{CEO} = \frac{1}{1-\alpha} I_{CBO}$$

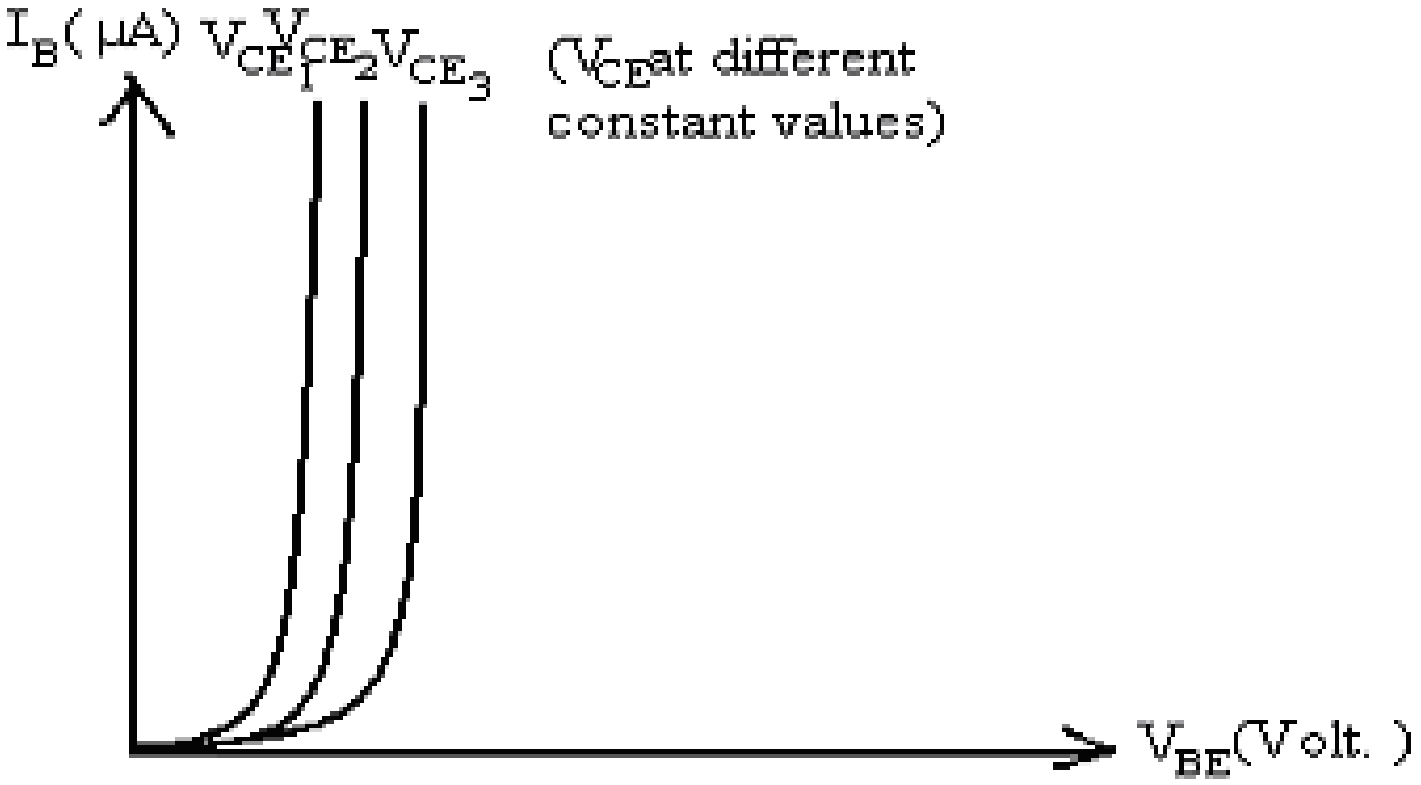
So,

$$I_C = \frac{\alpha}{1-\alpha} I_B + I_{CEO}$$

$$\Rightarrow \; I_C = \beta I_B + I_{CEO}$$

Input VI Characteristics

It is the curve between the current I_B and voltage V_{BE} at constant collector base voltage V_{CE}.



Output VI Characteristics

It is the curve between the current I_C and voltage V_{CE} at constant collector base voltage I_B.